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AN UNUSUAL LIGHTNING FLASH

By ALEXANDER MCADIE

One is almost tempted to say that lightning flashes are as a rule unusual because we note so many vagaries and departures from what we might expect. The discharge under consideration occurred April 26, 1929, about 11:55 a. m. on Canton Avenue, Milton, Mass., near the entrance to the grounds and residence of W. E. C. Eustis. The tree struck, a healthy ash, about 15 meters in height, stands on the east side of a paved avenue, 9 meters in width. There are other trees lining the avenue, which runs north and south, and there is a stone chimney east of the tree, the top being about 10 meters above the ground. One would naturally expect that the chimney rather than the tree would have been struck and damaged, for there is no lightning rod nor any metal roofing. Why the house (an entrance Lodge) was not struck and some damage done, we can not explain. The occupants state that they felt a heavy jar and heard a loud report

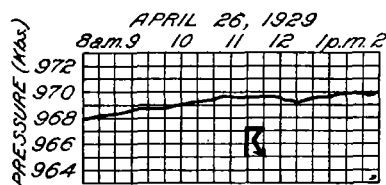


FIGURE 1.—Barograph trace

wires. One such can be seen in Figure 1, and it will be noted that the crossbars carrying telegraph wires, six in number, are as high above the ground and in every way as much exposed to a lightning hazard as the tree would seem to be. In all there are 10 metallic conductors and if the line of electrical strain between cloud and earth moved, as we assume that it did, from southwest to northeast, it must have passed across these wires a second previous to the discharge. If on the other hand, the line of strain moved from east to

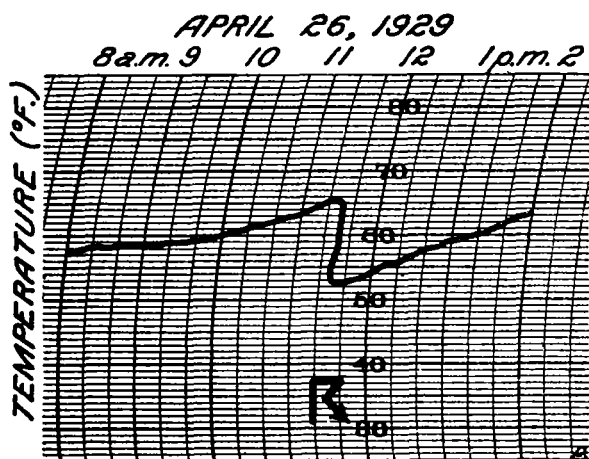


FIGURE 2.—Thermograph trace

west, the building, especially the chimney, being on higher ground, should have been struck. We find it hard to explain why this particular tree was hit, when other trees north and south of it, the poles and wires to the west, and the house to the east, were not injured in the slightest degree.

The location is due north of Blue Hill, distant about 1 mile. The instruments at the observatory show that an hour previous to the storm, i. e., at 10:30 a. m., the

surface wind was blowing from SW. by S. (230°) with a velocity of 12 meters per second (24 miles an hour) while the dark base of a large cumulus (but not as yet cumulonimbus) was 1,125 meters above the hill, moving from 225° with a velocity of 20 meters per second (33 miles an hour). The surface air temperature was 292° A. (66° F.) and the temperature at the base of the cloud 281° A. (49° F.). The surface relative humidity was noticeably low, being only 50 per cent, and the absolute humidity 8 grams per cubic meter of space. The vapor pressure at the ground at saturation would be 22 millibars (or kilodynes per square centimeter) and the vapor density 16 grams. It is thus plain that there existed near the ground a stratum of air that was relatively dry and so constituted a good insulating layer between cloud and earth. The aerostatic pressure was rising steadily but slowly from 968 millibars or kilodynes at 8 a. m. to 970 at the time of the flash. The barograph records do not show any characteristic thunderstorm notch, and here again the storm was unusual in that while there was a quick drop in temperature there were no noticeable wind shift or pressure discontinuities. In fact we regarded it at the time as a rather mild and unimportant thunder shower, although there had been at least one vivid straight line vertical flash in the west.

The bolt appears to have entered the tree not at the extreme tips of the upper small branches, but about 1 meter below, and we trace it first at the point marked "A" (fig. 4) on a branch about 10 centimeters in diameter. There is a straight groove on the top side of the branch, the bark being gouged out, varying from 1 to 4 centimeters in width. The groove is about 1 centimeter deep. The path follows the branch to the trunk and then goes practically in a straight line to the ground, down the south side of the tree.

At the point B (see fig. 4) a thicker branch joins the tree and there is just the slightest bend in the path of discharge but no tearing off of the bark or other damage than the path itself. At the point C, a large branch had at some earlier date been cut off (see figs. 4 and 5) leaving a nearly circular exposed part of the wood, 17 centimeters in diameter. Just to the right, i. e., to the east about 30 centimeters distant and less than 10 centimeters above the first, is a second circular opening, where another slightly larger branch had been cut off. Before the flash, both trimmings were dark and weather stained. The larger one remains so and was in no way affected. The smaller one had its outer ring of protecting bark torn off and the cambium exposed. The discoloration is complete and the flash evidently went around the spot in both directions. This is an interesting point, as showing that in this case at least lightning took the path of least ohmic resistance, which generally is not characteristic of discharges of extremely

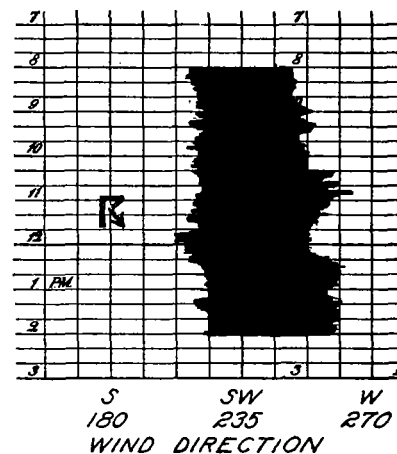


FIGURE 3.—Wind direction



FIGURE 4

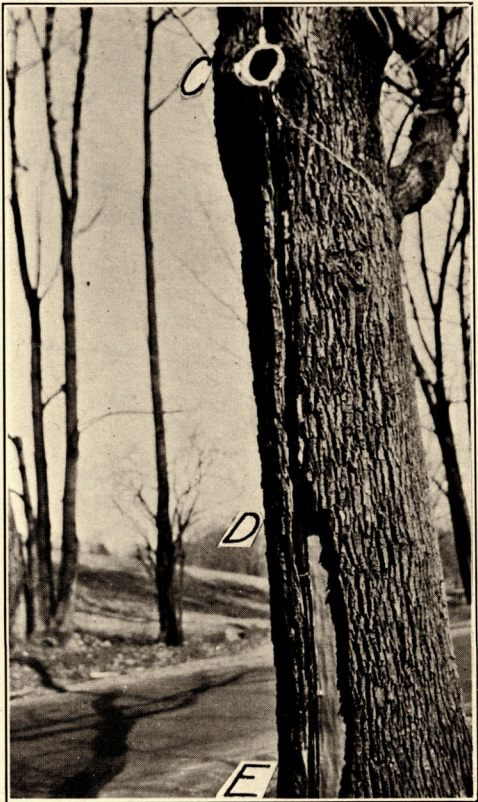


FIGURE 5

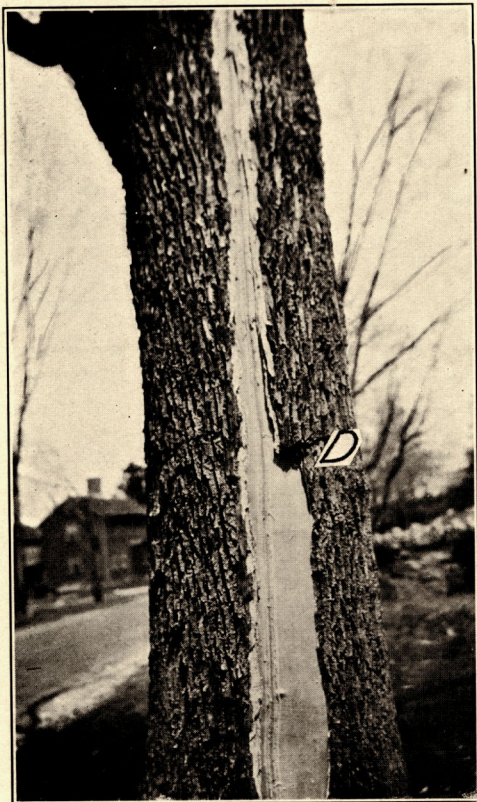


FIGURE 6



FIGURE 7

high voltage. We may estimate the voltage of this flash as of the order of 15,000,000 volts. The current intensity may have been 1,000 amperes; but these are only rough approximations. The cambium circle C (fig. 5) is 9 feet above the ground and the circumference of the tree at this point 150 centimeters. The circumference at the ground 250 centimeters. From C, the path is a shallow groove, with a deep V-shaped groove in the center, running down the tree to a point D (see figs. 5 and 6) where an explosive effect is seen, the water content of the cambium being evidently converted into steam at high pressure by the intense heat with the result that the bark was blown out and away. On both sides of the bare area, the bark is loosened to such an extent that a finger can be inserted between the bark and the cambium.

In Figure 6 a deeply cut inner groove can be seen, almost straight. This can be traced down to the ground (humus). In Figure 7, E, F, and G, the path can be distinctly seen as it plunges into the ground. Running directly west, the lightning made a clean cut furrow turning up the sod for a distance of 130 centimeters. In general the depth is 1 centimeter and width in places 13 centimeters. Reaching the limit of the sod, where a

gutter of the road begins—that is, a mixture of broken stone and asphaltum—the furrow disappears, and we assume that the energy of the discharge was at last completely dissipated by this grounding.

The disruptive effects seem to be more marked at the bottom of the tree than at the top. Indeed small branches and even twigs near the top and for some distance down, although quite near the path, that is, within 5 centimeters, were not injured in the least. This seems remarkable and we must assume a strong directive force in a vertical plane, and no splitting or side flashing. With most lightning discharges the disposition to split into branch discharges is marked. In near lightning this is also the case and in the 5,000,000-volt flash (near lightning) now used by F. W. Peek, jr., of the General Electric Co. in experimental work, as well as in the 3,000,000-flash shown in the MONTHLY WEATHER REVIEW, June, 1928, page 218, side flashes both up and down are to be seen clearly.

This flash then was unusual in that there is no twisting of the path, in that near-by and seemingly more exposed poles, trees, and buildings were not struck, and that there is no apparent explanation for the change in direction at the ground surface, nor for its abrupt ending.

WEATHER ABNORMALITIES IN UNITED STATES¹

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(SECOND NOTE)

Continuing previous studies on this subject I have selected for study the weather of 1921. This year was characterized in the United States by unusual warmth, particularly in the cold months of the year as well as in the summer months; an island of cool weather of which eastern New Mexico may be considered as the center developed in June, persisted in July although the center was somewhat west of its June position and in August was found far to the northwest and much enlarged in area. The explanation of this restricted cool area in an otherwise warm month and its persistence through three months is not at hand.

In other countries abnormal weather prevailed; from the British Yearbook of 1921 I excerpt the following:

In all parts of the British Isles the abnormally mild weather which set in just before Christmas continued nearly through the whole of January. A feature of the month was the persistence of mild damp winds from the southwest or west, with much low cloud. The movement of depressions was generally eastward across the British Isles, 16 primary and 2 secondaries have been charted.

February: The pressure distribution over west and northwest Europe during the month was largely dominated by a series of important anticyclones. Depressions followed paths well to the northward or southward of the British Isles. A very dry month in England and Wales.

March: The conditions over northwest Europe during March were of a westerly to southwesterly type, with frequent depressions in the neighborhood of the arctic circle and relatively high pressure between the Azores and Europe. As in the two preceding months there was a marked absence of severe wintry weather over western Europe generally and even in Sweden there was little frost after the 9th. Brief incursions of polar air were accompanied by snow in the northern districts of the British Isles at times in the first week, and in western districts on the night of the 28th but milder weather followed in each case. Ten depressions were charted moving almost due east about latitude 65.

June was very dry, July fine and warm, August unsettled, September mostly fine and warm, October very warm, sunny and dry, November cold, dry, and foggy, and December unsettled, mild, and windy.

Considering the Northern Hemisphere as a whole and using the data published in *Reseau Mondial* for 1921 it would appear that for the most part the year must be classed as a warm one.

In that publication the records of 269 stations having normal temperatures are given with the deviation from normal for each station. Combining these in a table by months it is found as shown in the table below that only the months September to November were relatively cool. The table follows:

TABLE 1.—Per cent of stations in Northern Hemisphere having positive departures in 1921. Mean monthly solar constant values in second line (after Abbot)

	January	February	March	April	May	June	July	August	September	October	November	December
Per cent.....	68	54	61	54	58	53	58	50	43	49	39	58
Solar constant.....	1.955	1.956	1.949	1.944	1.943	1.939	1.956	1.944	1.969	1.962	1.951	1.953

From this showing it would seem that some extra-terrestrial influence must have been operative and one naturally turns to changes in the incoming solar radiation. I have, therefore, included in Table 1 the monthly mean solar constant values as published by Abbot.² Thus it may be seen the solar constant values for January, February, July, and December were greater than the normal of 1.94 calorie, and that no single month was below that figure, two place decimals only being considered. The months of greatest solar constant values, however—September and October—were not associated with pronounced terrestrial temperature departures.

The sun-spot numbers for 1921 were not large; the minimum of 1923 was approaching. While the increase in solar radiation does not closely tie up with increased terrestrial temperatures it can not be dismissed from consideration. It might be argued that the effect of an increase or decrease in solar radiation should be felt more

¹ cf. Henry A. J. Weather abnormalities in United States this REVIEW. Vol. 56.

² Abbot, C. G. Smithsonian Misc. Coll. Vol. 80, No. 2, p. 6.